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ABSTRACT

The purpose of this study was to determine if first-, second-, and third-grade science textbooks integrate strategies to enhance literacy development in their texts, thereby reflecting an integrated language-arts perspective. Five sets of popular first-, second-, and third-grade science textbooks with 1990 and 1991 copyright dates were analyzed. Texts used were Holt, Rinehart and Winston's "Holt Science"; Scott Foresman's "Discover Science"; Silver, Burdett and Ginn's "Science Horizons"; McMillan/McGraw Hill's "Science Is Your World"; and Harcourt Brace Jovanovich's "Science, Nova Edition." Results indicated that a limited number of language-arts elements were used in the texts, with development of comprehension and use of varied instructional techniques found most frequently. These were followed in use by oral language, writing development, and the use of children's literature to promote interest in literacy and science; word recognition skills and varied assessment techniques were used least. Use of elements varied by grade and publisher, and within the main and supplementary portions of the texts. (Four tables of data are included; 48 references are attached.) (Author/RS)

Current Strategies for Literacy Development in Early Childhood Science Texts

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Abstract. The purpose of this study was to determine if first-, second-, and third-grade science textbooks integrate strategies to enhance literacy development in their texts, thereby reflecting an integrated language-arts perspective. Five sets of popular first-, second-, and third-grade science books with 1990 and 1991 copyright dates were analyzed. Results indicated that a limited number of integrated language-arts elements were used in the texts, with development of comprehension and use of varied instructional techniques found most frequently. These were followed in use by oral language, writing development, and the use of children's literature to promote interest in literacy and science; word recognition skills and varied assessment techniques were used least. Use of elements varied by grade and publisher, and within the main and supplementary portions of the texts.

In the last two decades much has been written about the integrated language-arts perspective on the development of early literacy. From this perspective, literacy learning is a concerted series of authentic, meaningful, and functional experiences involving varied genres of children's literature as the main source for actively involving children in reading and writing. These experiences take place in rich literacy environments created especially to encourage social collaboration among students during periods set aside for independent literacy activities. Instruction includes a conscious effort to integrate literacy learning with different content areas throughout the school day. It emphasizes learning that is self-regulated. Teachers and children become decision makers about instructional strategies, organization of instruction, selection of materials, and evaluation of performance.

The goal of such an approach is to develop not only a competent strategic reader but one who is motivated to read for pleasure and information. Learning theories undergirding this approach have been described by Dewey (1966), Piaget and Inhelder (1969), and Vygotsky (1978), as well as in more general philoso-

phies and viewpoints such as integrated language arts, literature-based instruction, whole language, language experience, and the writing-process approach (Bergeron, 1990; Goodman, 1989; Graves, 1975; Morrow, 1992; Stauffer, 1970).

An area of concern within this perspective is the integration of literacy development into content-area teaching, to make literacy learning more functional and meaningful. Because science is one area in which cognitive skills overlap with literacy objectives, both science and literacy learning could be enhanced if the materials and strategies used for instruction were more interesting for children and teachers.

Research shows that the primary teaching tool in science is the science textbook. Ogens (1991) found that 95% of science teachers use a textbook 90% of the time. Problems encountered with such dominant use of science texts include a lack of attention to varying abilities at different grade levels; lack of experimentation and scientific inquiry activities; and a lack of connection between science, the other content areas, and real-life issues. When taught in this manner, science focuses on the mere acquisition of facts rather than on attaining scientific literacy. In a synthesis of multiple studies that analyzed elementary science textbooks, Baker (1991) concluded that the textbooks required reasoning beyond the capabilities of students using them, and that the texts needed to be augmented to bring about significant learning.

In 1989, seeing that students were becoming frustrated and disenchanted with science, the National Science Foundation (NSF) published a document entitled *Project 2061* that focused upon developing scientific literacy. Some strategies advocated were the integration of literature, reading and writing, and other content areas into the science curriculum. Elementary-school science programs need to transcend their heavy dependency on textbooks by utilizing supplementary resources, and teachers must integrate science with existing curriculum subjects (Dowd, 1991).

In the real world, science, mathematics, reading, writing, and social studies are not separate entities. They are intertwined with each other and are crucial to everyday life. It is only logical, therefore, when teaching to integrate relevant subjects and the skills needed for learning as much as possible. To use a textbook alone causes science to be a dry subject in which students have difficulty relating the conceptual material to the real world. Research indicates that when science is integrated with other curriculum areas and uses appropriate children's literature for examples, difficult concepts are more easily understood and students learn both science and literacy skills (Moore & Moore, 1989). Use of an integrated language-arts perspective for literacy development and content-area teaching makes learning more meaningful and concepts more comprehendible.

With an emphasis on integrated curriculum for literacy instruction and the children's interest in science, it seems appropriate to study science textbooks to determine to what extent the integrated approach is being used. The purpose of this study was to determine if first-, second-, and third-grade science textbooks integrate strategies to enhance literacy development and thereby reflect an integrated

language-arts perspective. More specifically, the study asked:

- With what frequency do elements that promote literacy development appear in science textbooks prepared for grades 1, 2, and 3?
- Are there differences in the use of such elements in the main portion of lesson plans and the supplementary sections?
- Are there differences in the use of such elements in books for the different grade levels and among texts produced by five major publishers?

METHOD

Materials

The first-, second-, and third-grade books from five sets of science texts were selected for analysis based on their widespread use in primary and elementary science classes across the country. All of the chapters in the teacher's editions were analyzed, and all texts were 1990 and 1991 editions. The publishers whose books were used are identified below with the following philosophies for instruction taken from their own descriptions:

Holt, Rinehart, & Winston: Holt Science (1990). This science program includes the development of process skills through activities that encourage discovery learning, writing about science, and assessment techniques for evaluating children's learning.

Scott Foresman: Discover Science (1991). The science program encourages critical thinking skills through process activities that utilize problem-solving techniques and cooperative learning. There is an emphasis on language development, the use of reading strategies, and the whole-language approach to content-area teaching.

Silver, Burdett & Ginn: Science Horizons (1991). This series emphasizes the teaching of concepts by making the concepts relevant to students' lives. Strategies for learning include process-oriented activities such as problem solving, critical thinking, cooperative learning, and hands-on projects. There is an emphasis on teaching the nature of reading in content-area material, reading children's literature that is related to science, and writing about science topics being studied.

Macmillan/McGraw-Hill: Science in Your World (1991). This series encourages a holistic approach or an integrated curriculum for teaching science. The program is child-centered and relates its material to students' real-life experiences. Strategies for learning include problem-solving and cooperative-learning activities.

Harcourt Brace Jovanovich: Science, Nova Edition (1990). This series mentions the acquisition of scientific facts as an important goal. This content base is presented through process learning with hands-on activities, problem solving, and cooperative learning. Expanding children's curiosity about the field of science is a main goal.

Procedure

Research assistants analyzed 171 chapters in the 15 textbooks included in the study. They identified the number of times a chapter suggested activities that have been found to promote literacy development. The major categories and numerous subcategories by which texts

were analyzed were composed from a review of research in early literacy over the past twenty years, and the following categories were used for the analysis:

- oral language development
- comprehension development
- writing development
- use of children's literature to promote interest in literacy and science
- word recognition skills
- assessment techniques
- instructional techniques

During practice sessions, four research assistants analyzed portions of text to become familiar with the books and the elements to be identified. Reliability among the four assistants was determined by having all of the scorers analyze the same lesson plan for each of the five publishers at all the grade levels (a total of 15 selections for each). Calculations indicated the following reliability quotients: language development, 85%; comprehension, 90%; writing, 90%; use of literature to promote interest in literacy and science, 93%; word recognition skills, 88%; instructional and organizational techniques, 92%; and assessment techniques, 93%.

Activities in the main portions of lesson plans were coded separately from those in supplementary sections. Because supplementary sections were labeled differently from one publisher to the next (e.g., optional lessons, enrichment), for this study *supplementary* was defined as activities not required within the lesson at hand. Elements occasionally appeared in both the main and supplementary sections of the texts and were, therefore, counted in both (Morrow & Parse, 1990). An example of directions for lessons from each of the major categories is presented in Table 1. A description of the categories follows:

Oral Language Development. This category includes vocabulary, following directions, speaking in sentences, developing syntax, group discussions, and brainstorming (Dyson, 1984; Halliday, 1977; Smith, 1973).

Comprehension Development. Comprehension development includes retelling, prestory and poststory discussions, prelesson and postlesson discussions, relating science to real life, literal activities, inferential and critical activities, mapping and webbing ideas, and using pictures to understand print (Anderson, Mason, & Shirley, 1984; Crowell & Au, 1979; Morrow, 1984, 1985).

Writing Development. The elements in this category include recreational writing time for science, writing stories, composing outlines, writing questions, writing experience charts, sharing writing, cooperative writing, using writing folders, functional writing (lists, letters), attempted writing (drawing, invented spelling), prewriting discussions, drafting, conferencing, revising, editing, journal writing, writing expository text, and story dictation (Clay, 1975; Graves, 1975).

Use of Children's Literature to Promote Interest in Literacy and Science. This category includes recreational reading time for science, teacher reading science stories, children sharing science stories that they have read, using classroom and school library for science books, storytelling with science books, the number of science literature selections per text, children reading science books to each other, suggestions for a science literature collection in classroom, use of literature for

Table 1. Examples of Lesson Directions for Categories Analyzed

Category	Subcategory	Lesson Directions
Oral Language Development	Vocabulary	•Write the word *hibernation* on the chalkboard and pronounce it. Have students describe hibernation. •Possible Misconceptions: Some students think that hibernation is the same as sleep. Explain that hibernation involves a drop in body temperature and a slowing down of all body activities including breathing and blood circulation.
Comprehension and Development	Inferential Discussion	•Collect pictures of several adult animals and separate pictures of their young. Have students match the adults with their young and compare and contrast the similarities and differences between young animals and their parents. •Question: Why is it easy to match some babies with their parents, but more difficult to match others?
Writing Development	Writing Creative Stories	•Ask each student to write a creative short story about what it would be like if we had dinosaurs living near us today. Ask students to include such ideas as the kinds of problems that might exist if dinosaurs lived in crowded areas, such as cities.
Use of Children's Literature to Promote Interest in Literacy and Science	Book Suggestions for Students	The following books are suggested for additional reading: •Sattler. (1985). ***Pterosaurs, the Flying Reptiles.*** Lothrop, Lee & Shephard. (Grades 1-4) Discusses various species of flying reptiles which inhabited the earth during the age of the dinosaurs. •Roy, R. (1986). ***Big and Small, Short and Tall.*** Clarion Books (Grades 2-3). Introduces the concept of size among related animals.
Word Recognition Skills	Use of Context Clues	•Crossword puzzle games are provided with the use of context clues and the cloze procedure to identify words. For example: When you pour a _____ it changes shape.
Assessment Techniques	Standardized Tests	•Standardized tests are provided in the science text and workbooks at the end of each chapter.
Instructional Techniques	Cooperative Learning	•Assign students to work in four- to five-member teams to study Chapter 2, *How Animals are Different*. Students should work together to make sure that they and their teammates know the material in the chapter. After students have had enough time to study together, give them a test to complete individually (Chapter 2 Test, in the Test Book). Award Superteam certificates to teams whose average test scores exceed 90% and Great team certificates to teams whose average test scores exceed 80%

Table 2. Frequency of Literacy Elements — by Grade

Category	Grade 1		
	Main	Suppl.	Total
Oral Language Development	15.12	8.37	23.49
Comprehension	29.93	20.91	50.84
Writing Development	4.41	15.09	19.50
Science/Literacy Interest	1.60	5.97	7.57
Word Recognition Skills	3.06	2.75	5.81
Assessment Techniques	1.96	0.32	2.28
Instructional Techniques	33.79	53.61	87.40

teaching science skills, literature genres suggested or used in science lessons (newspapers, folktales, magazines, novels, picture storybooks, big books, poetry, biography, informational books), and discussion of authors and illustrators (Anderson, Wilson, & Fielding, 1985; Cullinan, 1989; Greaney, 1980; Morrow, 1992).

Word Recognition Skills. Although not an area one would expect to include in an analysis of science texts, a few elements in this category were identified as reasonable to analyze for, including sight words, environmental sight words, consonant sounds, vowels, word families, rhyme, and use of context clues (Hiebert, 1981; Juel, 1990).

Assessment Techniques. Elements in this category include collection of daily performance samples, observing and recording behavior, audiotaping, videotaping, evaluation conferences with children, teacher-made tests, standardized tests (Tierney, Carter, & Desai, 1991; Smith, 1990).

Instructional Techniques. Elements in this category include promoting cooperative learning, using workbooks and worksheets, whole-class instruction, small-group instruction, individualized instruction, modeling activities, teacher participating with children in activities, direct lecture instruction, activities providing for student choice, and science centers in the classroom (Brophy & Good, 1986).

RESULTS

Tables 2 and 3 present the average frequency of occurrence of the major elements we studied. Table 2 presents the information by grade, and Table 3 by publisher. The figures for the subcategories have not been included because, in many cases, the figures were very small or did not appear at all. The results will

Table 2. Frequency of Literacy Elements — by Grade *(continued)*

Grade 2			Grade 3		
Main	**Suppl.**	**Total**	**Main**	**Suppl.**	**Total**
16.10	9.06	25.16	16.63	11.30	27.93
36.37	21.72	58.09	37.93	24.53	62.46
4.42	15.30	19.72	7.98	17.86	25.84
2.17	10.32	12.49	2.41	11.20	13.61
2.87	2.63	5.50	2.37	1.89	4.26
2.11	0.41	2.52	2.65	0.70	3.35
24.42	41.72	66.14	23.19	42.87	66.06

be presented according to each of the major categories for analysis, the subcategories that occurred most and least frequently, the difference in occurrence of elements by grade and by publisher, and the frequency with which elements appeared in the main and supplementary sections of chapter lesson plans.

Oral Language Development

The most frequently used elements in oral language development were group discussion and vocabulary development. Developing syntax, speaking in sentences, following directions, and brainstorming were used infrequently. Oral language elements were found more often in main lesson plans than in supplementary sections of the teacher's manual in our analysis by grade and by publisher. Elements in this category increased in use from first to third grade. The programs differed from publisher to publisher in their use of oral language development activities. Silver, Burdett & Ginn and Macmillan/McGraw-Hill used the most activities in this category, Scott Foresman and Harcourt Brace Jovanovich (HBJ) were next, and Holt used the least.

Comprehension Development

The most frequently used elements in comprehension development were relating science discussions to real life, literal activities, inferential and critical activities, use of pictures to understand print, and prelesson and postlesson discussions. Strategies such as retelling, mapping and webbing ideas, and prediscussions and postdiscussions of stories were used infrequently. Few stories were present in the texts nor were there many suggestions to read literature related to science; consequently, such activities were not used. The development of comprehension was stressed more in the main portion of the lesson plans than in the supplementary sections when we analyzed both by grade and publisher. Elements in this category

Table 3. Frequency of Occurrence of Elements — by Publisher

Category	Holt			Scott Foresman		
	Main	Suppl.	Total	Main	Suppl.	Total
Oral Language Development	4.94	2.15	7.09	11.70	5.03	16.73
Comprehension	3.73	0.80	4.53	24.10	15.70	39.80
Writing Development	0.22	1.58	1.80	3.75	7.32	11.07
Science/Literacy Interest	0.92	2.11	3.03	1.08	3.72	4.80
Word Recognition Skills	0.49	0.41	0.90	2.86	2.31	5.17
Assessment Techniques	1.40	0.60	2.00	1.11	0.11	1.22
Instructional Techniques	16.80	20.90	37.70	17.20	28.20	45.40

increased in use from first to third grade. There were differences in the occurrence of comprehension strategies among publishers: Silver, Burdett & Ginn used the most elements; Macmillan/McGraw-Hill and Scott Foresman were next; and HBJ and Holt used the least.

Writing Development

Writing-development elements were used infrequently in the science texts that were studied. Functional writing (e.g., making lists and letter writing) and writing expository pieces appeared most often. The rest of the subcategories under writing development, such as writing stories, use of writing folders, and prewriting discussions, were used infrequently or not at all. Writing activities appeared more often in the supplementary sections of lessons, in our analyses by grade and by publisher, than in the main portions. Although the use of writing elements was infrequent at all three grade levels, third-grade texts showed more use than first- or second-grade books. Silver, Burdett & Ginn and Macmillan/McGraw-Hill had the highest frequency of writing elements, Scott Foresman and HBJ were next, and Holt was last.

Use of Children's Literature to Promote Interest in Literacy and Science

As Tables 2 and 3 indicate, suggestions for the use of children's literature to promote interest in reading and science rarely appeared. Those suggestions that appeared the most included using varied genres of literature for teaching science such as magazines, picture storybooks, and informational books. Activities such as the teacher reading science materials to children, time set aside for recreational reading of science books, children reading to each other and sharing the science literature they have read,

Table 3. Frequency of Occurrence of Elements — by Publisher *(continued)*

Silver, Burdett & Ginn			McMillan/ McGraw Hill			HBJ		
Main	**Suppl.**	**Total**	**Main**	**Suppl.**	**Total**	**Main**	**Suppl.**	**Total**
11.40	9.70	21.10	11.70	6.71	18.41	8.11	5.14	13.25
32.50	24.90	57.40	23.60	16.20	39.80	20.30	9.56	29.86
5.40	20.50	25.90	6.58	12.60	19.18	0.86	6.25	7.11
2.36	9.75	12.11	1.61	8.09	9.70	0.21	3.82	4.03
1.12	1.09	2.21	2.26	2.03	4.29	1.57	1.43	3.00
2.06	0.10	2.16	1.08	0.58	1.66	1.07	0.04	1.11
19.20	41.70	60.90	15.30	26.10	41.40	12.90	21.30	34.20

and having a place for science literature to be housed in the classroom were found very infrequently. When these elements did appear, they were usually in the supplementary section of a lesson rather than in the main portion when we analyzed both by publisher and grade. Elements in this category appeared in the second- and third-grade books more than the first-grade texts. Silver, Burdett & Ginn and Macmillan/McGraw-Hill used these elements most often. Holt, Scott Foresman, and HBJ all had very low frequencies of occurrence.

Word Recognition Skills

Although not an area one would expect to include for analysis in science texts, the integrated approach seeks meaningful and authentic ways to teach word recognition skills in all content areas. A few such pedagogical elements appeared infrequently. Those that appeared the most were the use of context clues and the development of sight words. Others, such as the development of environmental sight words, consonant sounds, vowels, word families, and rhyme, rarely appeared. Word recognition skills appeared equally in the main and supplementary sections of the lesson plans when they were analyzed by grade and by publisher. They were more frequent in the first- and second-grade texts than the third. All the publishers used these elements infrequently; however, Scott Foresman and Macmillan/McGraw-Hill used the most, HBJ and Silver, Burdett & Ginn were next, and Holt used the least.

Assessment Techniques

An integrated language-arts perspective requires alternative assessment techniques other than just standardized measures. Tables 2 and

3 illustrate the infrequent use of assessment tools in the science textbooks. The most frequently suggested assessment technique in the texts studied was, however, the use of standardized tests provided in the texts themselves. All other elements, such as collecting daily performance samples, observing and recording behavior, evaluative conferences between teacher and child, and teacher-made tests, were used infrequently or not at all. Assessment elements were found more often in the main portions of the lessons than in supplementary sections when we analyzed by grade and by publisher. Assessment measures were used more often in the third-grade books than in first- and second-grade books. There was little difference between publishers in the use of assessment techniques.

Instructional Techniques

An integrated language-arts perspective suggests not only the use of specific teaching strategies but also specific instructional and organizational techniques. The most frequently used techniques were direct instruction via lecturing to the whole class and the use of workbooks and worksheets. Elements such as promoting cooperative learning and a teacher's participation with children in science activities were used moderately. The rest of the elements in this category, instruction in small groups, instruction on a one-to-one basis, teachers modeling activities, providing for student choice, and inclusion of science centers in classrooms, were used the least. When used, the strategies in this category were found mostly in the supplemental sections of the lessons when we analyzed by grade and by publisher. There were more instructional techniques suggested for first grade, and the frequency of occurrence stabilized at a lower level for second and third grade. The publisher using the most instructional techniques was Silver, Burdett & Ginn, next came Scott Foresman and Macmillan/McGraw-Hill, and last were Holt and HBJ.

Summary of Categories Analyzed

Table 4 summarizes the results of all analyses discussed. The development of comprehension and the use of varied instructional and organizational techniques were found most frequently in the texts. These categories were followed in frequency by oral language development and writing development. Children's literature to promote interest in literacy and science, word recognition skills, and varied assessment techniques were used least. The use of elements within the main and supplementary portions of the lessons varied from one text to the next, as did the use of elements at different grade levels. Publishers differed in the use of elements studied, with Silver, Burdett & Ginn and Macmillan/McGraw-Hill using the most, Scott Foresman and HBJ next, and Holt the least.

DISCUSSION

Results of the study indicate that the science textbooks analyzed used a limited number of integrated language-arts elements, even though some of the publishers' descriptions implied that they contained integrated language-arts strategies. There was a consistent trend in the overall use of the strategies among publishers, with Silver, Burdett & Ginn and Macmillan/

Table 4. Frequency of Literacy Elements — Across Grades and Publishers

Category	Main	Suppl.	Grand Total
Oral Language Development	47.85	28.73	76.58
Comprehension	104.23	67.16	171.39
Writing Development	16.81	48.25	65.06
Science/Literacy Interest	6.18	27.49	33.67
Word Recognition Skills	8.30	7.27	15.57
Assessment Techniques	6.72	1.43	8.15
Instructional Techniques	81.40	138.20	219.60

McGraw-Hill using such elements most frequently, Scott Foresman and HBJ using them less so, and Holt using them least. The findings indicate how important it is that school personnel who purchase science texts evaluate content carefully, identify accurately all elements included, and gauge consistency between a publisher's description of a program and its actual content. Our results show that neither the main nor supplemental sections of the lessons in these texts contained high frequencies of language-arts elements, and that the texts presented science primarily by focusing on facts and adhering to the teaching practices of the past.

Oral language development, comprehension, and use of literature increased in use with grade. There were no difference between grades in writing development, assessment techniques, and instructional and organizational techniques. Skill development in word recognition appeared more frequently in first- and second-grade texts than in third-grade texts. Because the texts outlined fewer literacy strategies in the lower grade levels, it can be inferred that the books' publishers do not consider young children to be readers and writers, in spite of considerable research to the contrary (Sulzby, 1986). From an integrated language-arts perspective, the use of literacy learning strategies should be similar in all grades, although one does expect more emphasis on word recognition skills in the earlier grades, a practice that the books studied do adhere to.

It appears that publishers of science textbooks are aware of the integrated language-arts perspective, because they use its jargon in describing their books. They apparently are not, however, letting the perspective guide the classroom practice suggested or implied in their lesson plans. Publishers of such materials have the resources to make a difference. Educators and researchers, therefore, need to send them the best message about how the integrated perspective can be incorporated into science texts. Many of the same companies that publish basal readers also publish content-area texts. It seems that a cooperative effort

between the divisions in a company might bring about a better product in both areas. Possibly there needs to be a new direction toward the development of one totally integrated material for early childhood instruction in literacy development, science, and social studies.

No matter how innovative science texts are, however, they can never be the main and only source for learning. Teachers need to supplement instruction by enriching it in various ways with hands-on experiments and process learning experiences. Another avenue for enrichment is the use of children's literature. When teaching a unit on the "Changing Earth," books such as *How to Dig a Hole to the Other Side of the World* (McNulty, 1979) and *The Magic School Bus Inside the Earth* (Cole, 1986), which study the layers of earth, *Bringing the Rain to Kapiti Plain* (Aardema, 1981), which discusses a season of drought, and *Time of Wonder* (McClosky, 1957), about the coming of a hurricane, would substantially enhance such a unit of study. The following books would add interest, humor, and information to a study unit on plants: *A Tree is Nice* (Udry, 1956), *The Poison Ivy Case* (Lexau, 1983), *Discovering Trees* (Florian, 1986), *Johnny Appleseed* (Moore, 1964), and *Cherries and Cherry Pits* (Williams, 1986). Finally, the following books are suggested for study units on animals: *Animals Do the Strangest Things* (Hornblow, 1990), *What Do You Do With a Kangaroo?* (Mayer, 1973), *Animals on the Job* (Frulik, 1990), *Wild Animal Babies*, (Stouffer, 1990), and *Animals Should Definitely Not Wear Clothing* (Barrett, 1977). These books represent both narrative and informational pieces, and in some cases a combination of both. Combining textbook instruction based on the integrated language-arts approach with the use of children's literature is one way to make literacy and content-area teaching both informative and pleasurable.

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